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U. S. Department of Agriculture

THIS BULLETIN tells you how to select and install garden watering equipment for best results in vegetable production and most economic use of your electric water system. For just a few cents a day, electricity can pump enough water for an average-size farm garden. This water can supplement natural rainfall, carry the garden safely over periods of drought, and assure greater yields.

Extra attention to the garden will bring more fresh fruit and vegetables for summer eating or for canning or putting in your home freezer for winter meals. Making your electricity productive—no matter how large or small the job may be—helps your Nation, your community, and you.

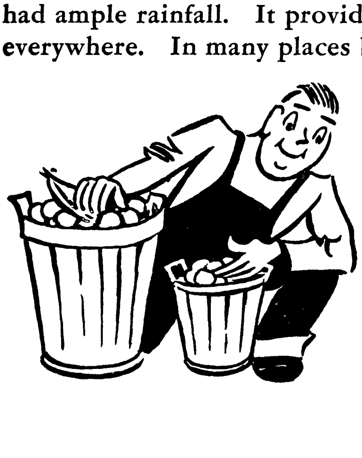
Contents

Using Electricity to Water Your Garden

By **Earl L. Arnold,** *power utilization specialist, Rural Electrification Administration*

Watering the garden with your electric water system may increase the yield of garden produce enough to pay all of your electric bill. Even more important, it can improve the diet of your family by supplying fresh vegetables of high quality for your table at times when you otherwise would not have them.

Garden watering is becoming more and more common every year even in those parts of the country where, in the past, we have thought that we had ample rainfall. It provides insurance against dry times that occur everywhere. In many places brief summer droughts are severe enough almost every year to damage gardens. During very dry seasons, watering or not watering may mean the difference between a good crop of high-quality vegetables and little or no crop of low-quality produce.

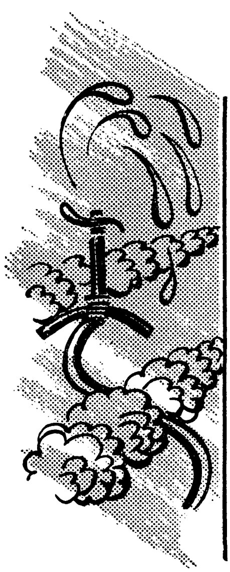


Many farmers have found that in most years a well-watered garden produces at least 50 percent more than one that depends entirely on rainfall.

What will garden watering cost you?

It is difficult to tell here just what the equipment to water your home garden will cost or how much it will be worth to you, but some figures to illustrate costs and benefits may be helpful. Unless your garden is within a few feet of a building with a sill cock on the outside of it you will likely need a pipe from your pump to the garden. In the garden you may need a frostproof hydrant. You will need garden hose to reach from the hydrant to the place where the water is to be distributed. You may need one or more sprinklers or one or more sections of porous hose.

If, for example, you are going to water a 90- by 120-foot garden with a pump that delivers 325 gallons per hour and a sprinkler that covers an 80-foot circle, the materials listed below might be needed. The costs given are for illustrative purposes only; there may be variation up or down in your own area, and you may need different items.



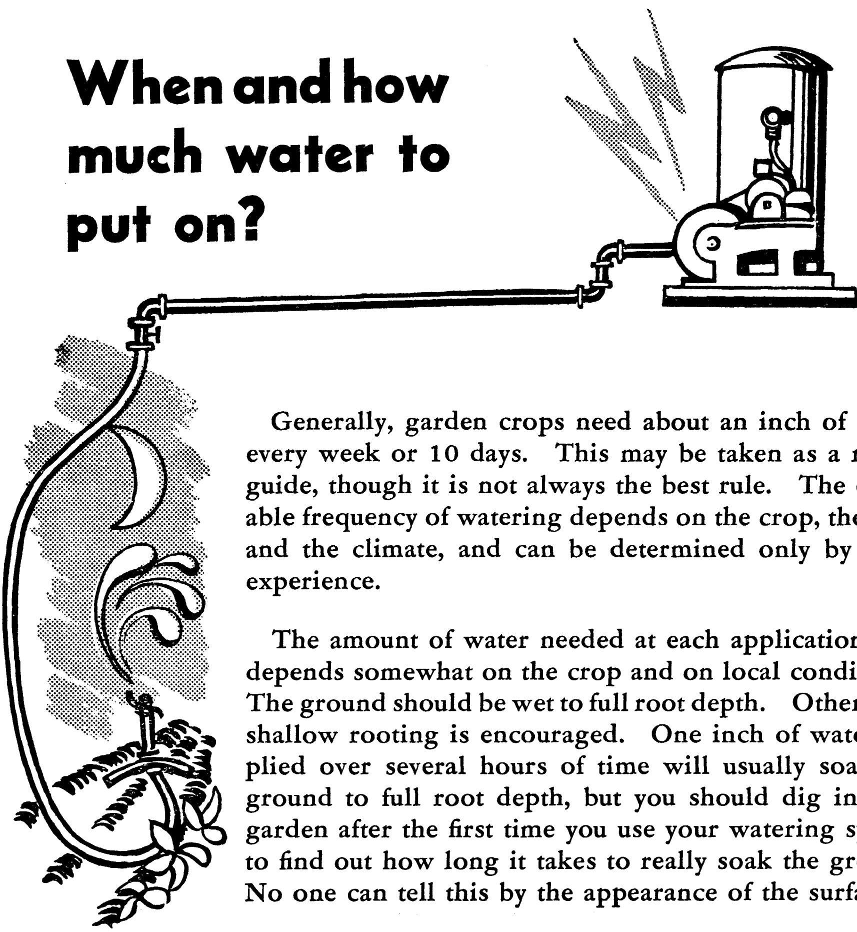
220 feet of 1-inch galvanized pipe at $0.20 per foot	$44.00
1 1-inch galvanized tee	.40
5 1-inch 90° elbows at $0.30 each	1.50
1 frostproof hydrant	10.95
50 feet of ¾-inch garden hose	9.00
1 rotary sprinkler	10.00
1 sprinkler stand	1.50
	77.35

If the well is not over 100 feet deep, it is likely that between 10 and 20 kilowatt-hours of electricity will be used each time 1 inch of water is put on this nearly one-quarter acre.

Is it good business for you to spend this much money just to water your garden? Again, we cannot answer here, but we can illustrate probable results.

Suppose that you now get only $50 worth of produce from your garden each year, although most farm gardens do better. Proper watering would increase this annual worth to at least $75, or an increase of $25. Operating costs for a year—power costs, maintenance of watering equipment, and the labor charged for watering—might cost $5. Depreciation on the equipment might run 7½ percent each year. On an investment of $77.35 this would be $5.80 for depreciation. Taking $10.80 (operating costs plus depreciation) from the gross increase of $25, leaves a net annual return of $14.20, an 18-percent return on the original investment.

When and how much water to put on?



Generally, garden crops need about an inch of water every week or 10 days. This may be taken as a rough guide, though it is not always the best rule. The desirable frequency of watering depends on the crop, the soil, and the climate, and can be determined only by local experience.

The amount of water needed at each application also depends somewhat on the crop and on local conditions. The ground should be wet to full root depth. Otherwise, shallow rooting is encouraged. One inch of water applied over several hours of time will usually soak the ground to full root depth, but you should dig in your garden after the first time you use your watering system to find out how long it takes to really soak the ground. No one can tell this by the appearance of the surface.

Since it may take as long as 3 or 4 days to water your whole garden, it may be desirable to start watering only 3 or 4 days after a soaking rain.

You may find it best to water your garden in the evening or at night. At those times less water will be lost by evaporation and your pump will be furnishing the water at hours when it will be called on to supply less water for other purposes. The full capacity of the pump then will be available for the garden. This is important on many farms, since at certain times of the day nearly the full capacity of the pump may be needed for other farm purposes. If the garden is being watered at the same time, the amount of water available for other purposes will be reduced and the garden watering equipment will not operate at its best.

If watering is to be done at night, it is highly desirable to select sprinklers or other water distributing equipment that will apply water to a given area slowly enough that they can be left in one location for as long as 8 to 9 hours. This will eliminate the need for moving the watering equipment during the night.

How much garden can be watered by your water-system pump?

The electric water system pumps usually installed on farms are not large enough to irrigate field crops. Most of them, however, can be used to water home gardens, if the installations are carefully planned and properly managed, and the well will furnish water for long periods of pumping.

Perhaps some information on the size of garden that different size pumps can water will help you in planning your garden watering. One

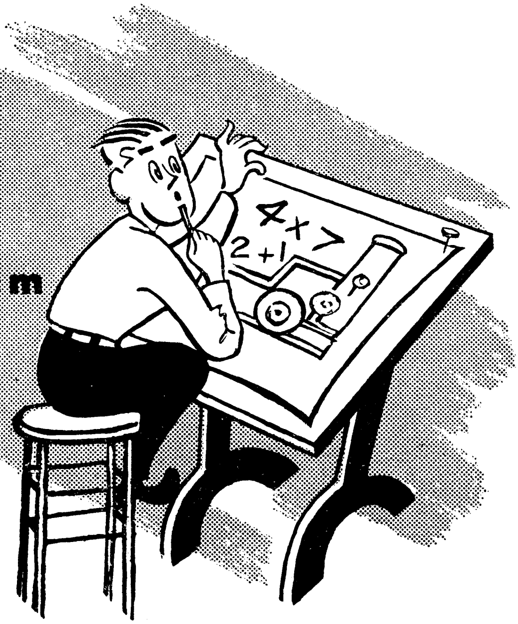
inch of water on 1 acre is 27,152 gallons. A pump that delivers this much water in a week of continuous operation is pumping about 160 gallons an hour. If watering were continuous all of the time and the pump did not have to furnish water for any other purpose, a 160-gallon-per-hour pump could therefore water an acre in a week. However, since few people will begin watering the garden as soon as it stops raining and our usual water-system pumps must furnish water for other farm and household needs, it is seldom practical to water the garden for 24 hours of the day or for 7 days a week.

If you wait for 3 or 4 days after a soaking rain before starting to water, the entire garden will have to be covered in 3 or 4 days' time or some parts of it will become too dry. Also, because of other water needs, you may be able to use the pump for garden watering only at night. This means that you may have to cover the whole garden in 24 to 30 hours of pumping time. The following table shows how much garden can be watered by different size pumps if the equivalent of 1 inch of water is put over the whole area in 24 hours of pumping.

Approximate size of gardens that can be watered in 24 hours of pumping by different capacity pumps

Capacity of pump (in gallons per hour)	*Size of garden (in acres)*
250	0.22
300	.26
350	.31
400	.35
450	.40
500	.46
550	.49
600	.53
650	.58
700	.62
800	.71
900	.80
1,000	.88
1,100	.97
1,200	1.06
1,300	1.15
1,400	1.24
1,500	1.33

Plan your system so your pump will run continuously



You will want to plan and install your garden watering equipment so that your pump will run continuously while your garden is being watered. Continuous pump operation will reduce the amount of electricity consumed, but even more important, it will eliminate the wear and tear on the pumping equipment caused by frequent starting and stopping. Also, continuous pumping means uniform rate of water discharge in the garden. A pump that starts and stops as water is put on the garden means wide variation in water pressures and lack of uniform distribution.

You can be sure that your pump will run continuously by carefully selecting and installing piping and other watering equipment so that they are adapted to the capacity of the pump. Most of the pumps in farm water systems are adjusted so that they stop when the pressure reaches 40 pounds. If 40 pounds is more than the pressure at the sprinkler plus that used up in the pipe and garden hose when water is flowing at the pumping rate, continuous operation is assured.

But you want to know how to tell when 40 pounds is more than the sprinkler pressure plus the pressure loss from pipe friction. If you buy a high-quality sprinkler, information will come with it or be available in the literature describing it, telling how much water it delivers at several different pressures. If you buy cheap lawn-type sprinklers you may have to try out several to find one or two that release the water as fast as the pump supplies it. A study of Chart 1 on the next page will help you to select the correct pipe size. Chart 1 gives the correct pipe sizes so that not more than 5 pounds of pressure will be used up in overcoming pipe friction, at different rates of water flow in the common garden hoses. Table 1 gives the amount of pressure used up in overcoming friction in the common garden hoses at different rates of water flow.

Chart 1

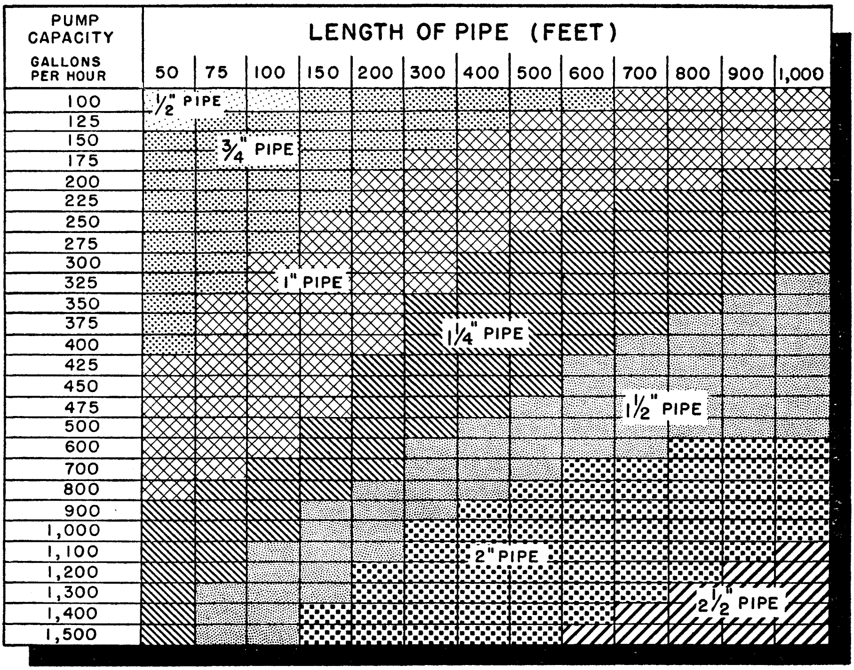


Table 1

Table I.—Pressure Loss From Friction in Usual Garden Hose

Rate of flow (GPH)[1]	Size of hose			
	5/8 inch		3/4 inch	
	Per 25 feet	Per 50 feet	Per 25 feet	Per 50 feet
	Pounds	*Pounds*	*Pounds*	*Pounds*
200	0.48	0.95	0.25	0.50
225	.59	1.18	.31	.62
250	.71	1.41	.38	.75
275	.84	1.68	.45	.90
300	.98	1.97	.52	1.05
325	1.14	2.28	.61	1.23
350	1.30	2.60	.70	1.40
375	1.48	2.85	.79	1.58
400	1.65	3.30	.90	1.80
425	1.83	3.66	1.00	2.00
450	2.03	4.06	1.13	2.25
475	2.21	4.42	1.24	2.47
500	2.46	4.92	1.36	2.72
525	2.68	5.36	1.49	2.99
550	2.92	5.85	1.62	3.23
575	3.13	6.26	1.76	3.51
600	3.38	6.77	1.90	3.80

[1] GPH=gallons per hour.

A couple of examples may help in understanding this.

Example No. 1: *Suppose:*

1. You will use 150 feet of pipe to reach from the pump to the hydrant in the garden.

2. Your garden is large enough so that 100 feet of garden hose will be needed to reach from the hydrant to all of the sprinkler locations.

3. Your pump has a capacity of 300 gallons an hour when pumping against 35 pounds pressure.

First, you select a sprinkler that will deliver water at a rate of 300 gallons an hour at a pressure of 25 to 30 pounds, leaving a margin of 5 to 10 pounds of pressure to overcome friction in the pipe and garden hose.

Second, look at Chart 1 to find the correct pipe size. Look down the column headed "Pump Capacity Gallons per Hour" until you find the figure "300"—your pump capacity. Follow across from that figure to the column headed "150 ft."—the length of the pipe from the pump to the garden hydrant. You will notice that you are now in the section of the chart labeled "1-inch pipe." This means that 1-inch pipe in this situation will not use up more than 5 pounds of pressure and would be satisfactory.

Next, you find the size of hose needed. This is the way. In Table 1, in the column headed "Rate of flow, GPH" you find the figure "300." Follow across the table from "300" to the two columns headed "Per 50 Ft." You will note that with ⅝-inch hose you would lose 1.97 pounds of pressure in each 50 feet. For 100 feet of hose it would be twice that amount, or 3.94 pounds. For ¾-inch hose, you would lose 1.05 pounds in each 50 feet or 2.1 pounds in the 100 feet.

Adding the pressure loss in the 150 feet of 1-inch pipe and in the ⅝-inch garden hose, you get about 8.94 pounds loss. In the pipe and the ¾-inch hose the loss would be about 7.1 pounds. Since the sprinkler

selected will use between 25 and 30 pounds of pressure, the pressure at the pump if the ⅝-inch hose is used would be between 33.94 pounds and 38.94 pounds. If the ¾-inch hose is used, the pump pressure will be between 32.10 pounds and 37.10 pounds. In either case the pump would run continuously, but it would be safer to use ¾-inch hose. The top pressure of 38.74 pounds at the pump with the ⅝-inch hose is so close to 40 pounds that slight errors in installation might raise it enough so that the pump would stop.

Example No. 2: *Suppose:*

1. 300 feet of pipe will be needed to reach the hydrant in your garden.

2. 150 feet of garden hose will be needed to reach from the hydrant to the farthest sprinkler locations.

3. Your pump has a capacity of 400 gallons an hour when pumping against 35 pounds pressure.

First, in Chart 1 you will see that 1¼-inch pipe will be needed to keep the pressure losses in the pipe below 5 pounds.

Second, you decide to use two sprinklers, each of which delivers 200 gallons per hour at 25 to 30 pounds pressure instead of one sprinkler which delivers 400 gallons per hour. This means that two garden hoses, each carrying water at a rate of 200 gallons per hour, will be needed from the hydrant to the sprinklers.

Third, you look at Table 1 and see that 200 gallons per hour through 50 feet of ⅝-inch garden hose uses up 0.95 pound of pressure whereas 200 gallons per hour through 50 feet of ¾-inch garden hose uses up 0.5 pound. In 150 feet three times as much pressure would be used up. With ⅝-inch hose this would amount to 2.85 pounds, and if you used ¾-inch, it would amount to 1.50 pounds.

Since the sprinklers require 25 to 30 pounds pressure the use of ⅝-inch garden hose would give a pressure of about 32.85 to 37.85 pounds at the pump, and ¾-inch hose would give pump pressures of

about 31.50 to 36.50 pounds. All of these pressures are enough below the 40-pound shut-off pressure of the pump to allow for small unexpected variations, so that it would be desirable to use the cheaper ⅝-inch hose.

In each of the above examples, it is assumed that the garden and the pump are on approximately the same ground level. However, we have to allow for differences in elevation. If the gardens in the examples discussed had been higher than the pumps, additional pump pressure would have been required for the same results. For each 10 feet difference in elevation from the pump to the garden, add—or subtract—4.34 pounds pressure. In other words, each pound of pressure will lift the water 2.3 feet; 10 pounds of pressure will lift it 23 feet.

Now then, if the gardens discussed had been 23 feet *higher* than the pumps, the pumps would have had to run against 10 pounds higher pressures to get the same results with the same pipe, the same garden hose and the same sprinklers.

If the gardens discussed had been 23 feet *lower* than the pumps, the pumps could have run against 10 pounds lower pressures. You could have selected sprinklers, pipe sizes, and hose sizes as though the pumps stopped at 50 pounds when they actually stopped at 40 pounds.

Is your well adequate?

Before putting in garden watering equipment you will want to assure yourself that your well will furnish enough water to do the job. You probably know your well better than anyone else does, but in deciding you should remember that it will be called on to furnish water at the full capacity of your pump for a considerable period of time. The increased value of your watered garden will determine how much you can afford to spend to improve your well, but if you are considering improving your well for other reasons, garden watering will help to pay the cost.

Is the motor on your pump large enough?

The motors on some jet-type water pumps are overloaded. Continuous running will cause these motors to overheat and be damaged. If you have a jet-type pump it would be well for you to check with your dealer before using it for garden watering or any other purpose that makes it run for more than a few minutes at a time. It may be necessary for you to have your dealer get a motor of the next larger size and to substitute this on your pump before the pump is suited to continuous running.

The motors on most pumps are just large enough for the pumps. This makes it necessary to have good wiring to them. As a result of poor wiring, many pump motors burn out in the intermittent operation of everyday use. If they are called on to run continuously for hours at a time, the danger of motor burnout from poor wiring is much greater.

It is not practical to raise the shut-off pressures above 40 pounds on most jet-type pumps, but most other types will operate satisfactorily at higher pressures. An example of the need for increased shut-off pressure is when the garden is much higher than the pump. If your garden is 23 feet higher than the pump, a shut-off pressure of 50 pounds will be needed to give the same results as a 40 pound shut-off pressure on the same level. Raising the shut-off pressure increases the load on the motor and may cause it to burn out unless a larger motor is substituted.

Methods you may use to apply the water

You have a choice of several ways of putting the water on your garden. The most common method and usually the most practical is the use of portable sprinklers. Other common methods include perforated-pipe sprinklers, porous hose, and furrows.

Portable sprinklers do not require a large investment in equipment and they take comparatively little work. They are practical on almost all plants, on most soils, and under most topographic conditions.

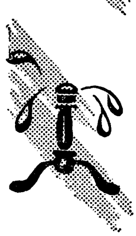
Perforated-pipe sprinklers are widely used by commercial truck farmers and market gardeners. The pipes with small holes or nozzles along them are often supported on poles and extended across the garden. These sprinklers are relatively expensive and may require water faster than it can be supplied by the regular farmstead pump, particularly if long lengths of pipe are used.

Porous hose is made of canvas duck through which the water oozes along the entire length. They must be moved frequently and they usually water only small areas at each setting. They must be laid almost on the contour. They are satisfactory only in very small gardens.

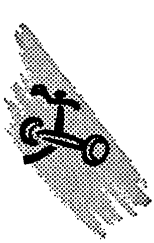
The furrow method of watering requires very little equipment but more work than any other method. It is suitable only to certain soils and to smooth topography.

How you select the right portable sprinkler

There is a very large variety of portable sprinklers on the market from which you can choose. Most of them may be classified as being stationary, rotating, or oscillating.



Those with stationary heads are usually cheap devices. They are intended for watering lawns and flower beds. Because of the small area that they water at each setting, they are suitable only for use in small gardens. On many farms the number of different settings necessary to cover the whole garden with these devices makes watering a nuisance. Often, they distribute water as fast as sprinklers that cover much larger areas. To avoid excessive runoff it is then necessary to move them before the ground has become well soaked. Most of them throw a circular or fan-shaped spray although a few throw a cone-shaped spray straight upward. Some people prefer the fan-shaped spray since this wets the ground in only one direction from the sprinkler. The sprinkler can be approached and moved while it is running, without the operator getting wet or getting his shoes muddy.



Oscillating sprinklers usually throw a fan-shaped spray, but the mechanism is made so that the spray is

thrown first to one side and then to the other. They are not as common as either the stationary sprinklers or the rotating sprinklers. Most of them are made for lawn use and apply water more rapidly than is desirable in the garden. The areas that they cover are greater than the areas covered by most stationary sprinklers but are not nearly as large as those covered by some of the better rotating sprinklers.

The use of rotating sprinklers is by far the most common. In general, they are to be most highly recommended.

Rotating sprinklers fall into two groups: (1) those that are built for lawn watering and (2) those built for irrigation. This is not a fixed classification and there are some sprinklers that would be difficult to classify into one or the other group. As a usual thing the lawn-type sprinklers are relatively inexpensive devices whereas the irrigation types are better built, are more uniform, and give a more even water distribution. Many of the lawn-type sprinklers will place water unevenly and as fast over an area 30 feet in diameter as a better irrigation type will place water fairly evenly over an area 80 feet in diameter. Some of the better irrigation types will water an area that is approximately square. Others are adjustable so that the same sprinkler will cover only part of a circle or a complete circle.

There is a wide variety of types of nozzles in use on lawn-type sprinklers. Exceptions will be found to almost anything that might be said about them. Most of the irrigation sprinklers have plain nozzles that are rather accurately made with standard-size openings. The rates of flow through these plain nozzles depend on the sizes of the openings and the pressures in the sprinklers. Although they cost more, the irrigation-type sprinklers are usually better buys for garden watering. Table 2 shows how fast you can expect nozzles with different size openings to deliver water.

Table 2.—Rate of Water Flow Through Four Sizes of Plain Sprinkler Nozzles

Pressure (pounds)	GPH [1] through 1/8-inch nozzle	GPH [1] through 5/32-inch nozzle	GPH [1] through 3/16-inch nozzle	GPH [1] through 7/32-inch nozzle
20	120	180	260	350
25	130	205	290	390
30	145	225	325	430
35	160	245	350	470
40	175	265	375	500

[1] GPH=gallons per hour.

The area covered by a rotating sprinkler at one setting depends on the size of the nozzle, the pressure in the sprinkler, the angle (from the horizontal) at which the water is discharged into the air, and the speed of rotation. A sprinkler rotating rapidly will cover a smaller area than if it rotates slowly. The height of the nozzle above the ground also has some effect on the area covered.

Perhaps you can best see the importance of having a sprinkler that covers a large circle by looking at the drawings in figures 1 and 2. You will notice that both of these drawings represent gardens 120 feet long and 90 feet wide. The garden in figure 1 is being watered by a sprinkler that covers a 40-foot circle while the one in figure 2 is being watered by a sprinkler that covers an 80-foot circle.

The black dots represent the various sprinkler settings and each circle represents the area watered when the sprinkler is at its center. The same pattern of water distribution is used in both gardens. In both cases, every spot is watered from at least two different sprinkler settings except for a small area in each corner and a few little areas along each side. You will notice that 24 settings of the 40-foot sprinkler are needed to do the same job that 6 settings of the 80-foot sprinkler would do. Any sprinkler that covers only half as wide a circle as another one will take 4 times as many settings to cover the garden in the same way. A sprinkler that covers a large circle reduces the work and bother of moving it, and if it delivers water at the same rate as the one covering the smaller circle there will be less runoff.

You will need one or more sprinklers that will put water on the garden at the same rate that the pump delivers it. For example, if your pump pumps 360 gallons per hour you might use one sprinkler that delivers 360 gallons an hour, or two, each of which delivers 180 gallons an hour, or three, each of which delivers 120 gallons, and so on.

The other important thing is that water must be *put on each square foot slowly enough so that it soaks in instead of running off.* You determine the rate that you put water on each square foot by the number of sprinklers you use and by the area that each sprinkler covers. The importance of the size of the area covered by each sprinkler can be seen in this example. Suppose you have three different sprinklers each of which delivers 360 gallons an hour. Also suppose that one of these covers a 20-foot circle, another a 40-foot circle, and the third an 80-foot circle. The one covering the 20-foot circle will place 10.3 gallons per hour on each square yard of soil. The one covering the 40-foot circle will place 2.6 gallons per hour on each square yard of soil, and the 80-foot one will put 0.65 gallon per hour on each square yard.

FIGURE 1

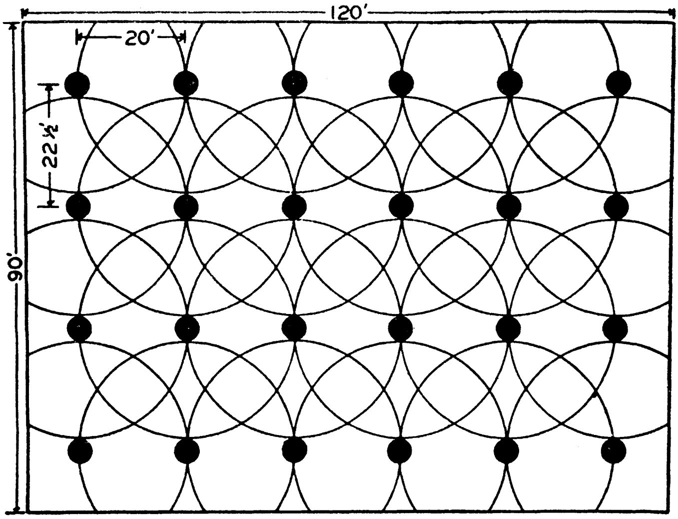
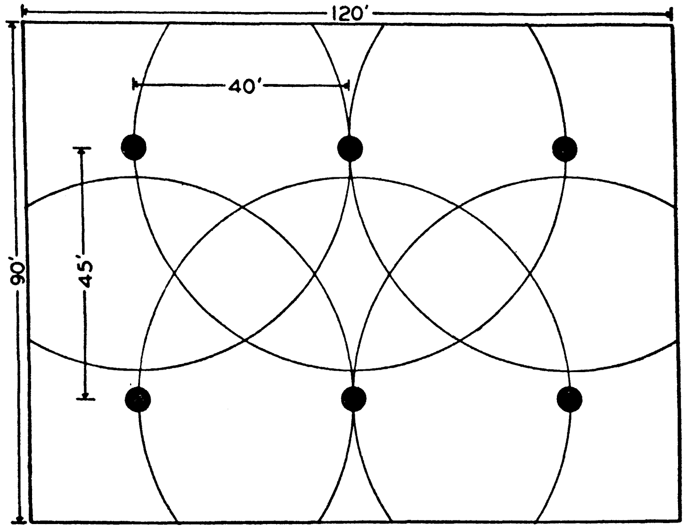


FIGURE 2



You may use porous hose

Porous hose may be substituted for sprinklers in distributing water on the garden. This is satisfactory under some conditions, but it usually requires more attention. The porous hose is laid between rows of vegetables and within a short time it will have delivered enough water so that it must be moved to the next row space. On many soils water may run off before the soil is well soaked. If a small size, heavy hose is used so that the water is applied more slowly, several hoses in use at the same time may be needed to keep the pump running. It is also necessary to lay each section of hose practically level. If one place is somewhat downgrade from another the lower place will deliver more water.

Porous hose is a tube of canvas duck usually of 8-, 10-, 12-, or 14-ounce weight. It may be 2 to 3 inches in diameter and often comes in 25-foot or 50-foot lengths. One end is closed. The other is connected to an ordinary garden hose.

Porous hoses differ so much that fixed statements cannot be made about the amount of water they will deliver, but in your early planning you may assume that 50 feet of 8-ounce hose will need about 300 gallons per hour.

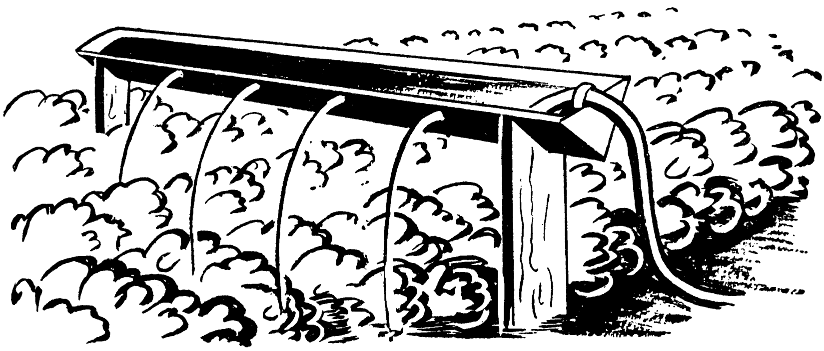
You can get some idea of the relative amounts of work involved in moving porous hose and in moving a sprinkler if you will compare the area covered by each at one setting. If your garden rows are 2 feet apart, a 50-foot length of porous hose will water 100 square feet at each setting. A sprinkler covering a 40-foot circle will water 1,257 square feet at each setting. Since sprinkled areas must be overlapped, each setting of the sprinkler might cover about 600 square feet of new area. From this you can see that you would need six 50-foot lengths of porous hose to do the work of one 40-foot sprinkler. Of course, if your rows

are 3 feet apart, four 50-foot lengths of porous hose would do the same work.

Wind does not affect the water from a porous hose as it does the spray from a sprinkler, and a porous hose does not wet the leaves of the plants.

Since porous hose is made of canvas it will mold and rot quickly if it is left damp. Some hose is specially treated to prevent mildew. Such treatment may reduce the damage. However, the hose should never be left lying on the damp ground after watering is completed, and should be hung up to dry as soon as it is taken from the garden.

You may use the furrow or ditch method



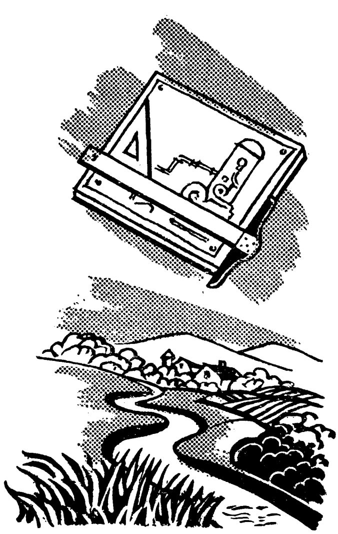
Some people use the furrow or ditch method of garden watering. This takes less equipment but more work than the other methods. It is not suited to porous soils that absorb all of the water before it can flow to the other end of the furrow. It works best if the garden has a very gentle slope. Because of the extra work that it takes, it is best suited to very small gardens.

You may want to water several rows at once. You can do this by using a V-shaped trough. The trough is placed level across several rows. It has holes one-half inch or larger bored in one side, spaced the width of the rows. These holes must be in a straight line parallel to the length of the trough. Water from the garden hose run into the trough will flow from each hole into a separate furrow. You may need to do a little experimenting to get a trough of the right length and holes of the right

size so that the pump will run continuously without overflowing the trough. Since the use of a trough waters several rows at once, it applies water more slowly to each row and makes less frequent moving of the garden hose necessary.

The furrow method requires more water than good sprinklers or porous hose. The end of the furrow into which the water flows must be considerably over-watered if the far end is to get enough.

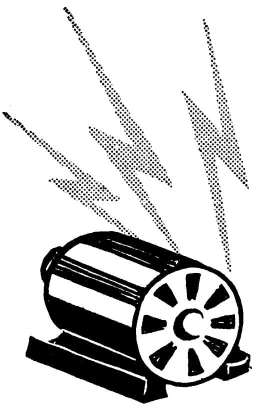
Irrigation for your small truck patch or commercial garden too large to be watered from your farm water system



You may find it profitable to irrigate your truck patch or commercial garden of 2, 3, or more acres, even though this is beyond the capacity of your farm water system pump. Much of the planning is the same as for watering your home garden, but you also have the problems of water source, special pumping equipment, more expensive piping, and more expensive sprinkling equipment. Porous hose and furrow-types of watering are seldom used for garden areas this large because their use takes too much time and labor from other work. Since 27,152 gallons are needed to put an inch of water on an acre a good water source is essential. Lakes or streams that flow through the dry seasons may be ideal if they are located nearby. In some States, water rights of other land may prevent your using these sources. However, you likely will find

that this is not a serious problem if you live in an area where irrigation is used only to supplement rainfall. If you are in doubt about this, it would be well for you to investigate before you put in an expensive installation.

One or more good wells may furnish the needed water. If you are not familiar with the possibilities of getting abundant water, you may find it desirable to consult local well drillers, neighboring farmers, your county agent, your power supplier, or other persons who know the local situation.



The electricity for your pump will be your most important operating cost. If you have a properly selected and installed pump, the size and length of the pipe from the pump to the place where the water is used will have a lot to do with the amount of electricity used. Chart 1 on page 9 may give you some idea of the size of pipe you will need, but it will be worth the cost to have an engineer calculate the needed sizes.

A large-size household-type pump may be suitable for irrigating 2 or 3 acres. For larger areas you will need a centrifugal, a turbine, or a heavy-duty piston type pump. Centrifugal pumps are best for low water lifts. Turbine pumps are best for deep wells. Heavy-duty piston pumps are good for pumping from shallow wells or surface sources when the water has to be forced through long pipes or to high elevations.

Many truck gardeners use perforated-pipe sprinklers instead of small portable sprinklers. The perforated pipe extends across the garden. There is a series of small holes or nozzles on it which spray the water 20 to 50 feet on either

side. Some of them are equipped with devices that automatically throw the water first to one side and then to the other.

You should get engineering assistance in planning a large installation. Small improvements in efficiency may mean many dollars saved in operating costs.

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